$1.00

Simpson

INSTRUMENTS THAT STAY ACCURATE

OPERATOR'S MANUAL

WARNING

For safe usage, it is essential that the operator read this manual carefully before using the instrument for any measurements.

SIMPSON 360
DIGITAL
VOLT-OHM-MILLIAMMETER

SIMPSON ELECTRIC COMPANY

853 Dundee Ave., Elgin, Illinois 60120
Area Code 312, Telephone 697-2260
In Canada, Bach-Simpson, Ltd., London, Ontario

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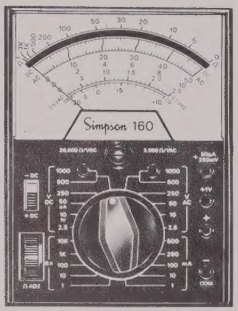

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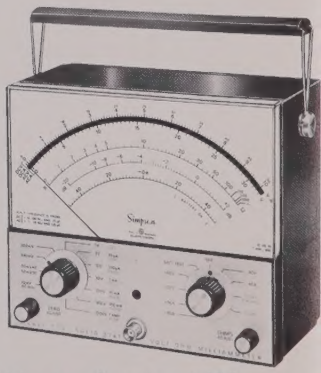

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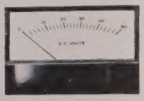

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OPERATOR'S MANUAL

SIMPSON 360 DIGITAL VOLT-OHM-MILLIAMMETER

SIMPSON ELECTRIC COMPANY
853 Dundee Ave., Elgin, Illinois 60120
Area Code 312, Telephone 697-2260
In Canada, Bach-Simpson, Ltd., London, Ontario

Printed in U.S.A.
Rev. 2-75 HINZ 1000

Part No. 5-116268

Figure 1-1. Simpson 360 Digital Volt-Ohm-Milliammeter

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WARNING

The Simpson 360 is designed to prevent accidental shock to the operator when properly used. However, no engineering design can render safe an instrument which is used carelessly. Therefore, this manual must be read carefully and completely before making any measurements. Failure to follow directions can result in a serious or fatal accident.

SHOCK HAZARD: As defined in American National Standard, C39.5, Safety Requirements for Electrical & Electronic Measuring & Controlling Instrumentation, a shock hazard shall be considered to exist at any part involving a potential in excess of 30 volts rms (sine wave) or 42.4 volts DC or peak and where a leakage current from that part to ground exceeds 0.5 milliampere, when measured with an appropriate measuring instrument defined in Section 11.6.1 of ANSI C39.5.

NOTE: The proper measuring instrument for the measurement of leakage current consists essentially of a network of a 1500 ohm non-inductive resistor shunted by a 0.15 microfarad capacitor connected between the terminals of the measuring instrument. The leakage current is that portion of the current that flows through the resistor. The Simpson Model 229-Series 2 AC Leakage Current Tester meets the ANSI C39.5 requirements for the measurement of AC leakage current and can be used for this purpose. To measure DC Leakage current, connect a 1500 ohm non-inductive resistor in series with a Simpson 0-500 DC microammeter and use this as the measuring instrument.

SECTION I

INTRODUCTION

1.1 GENERAL

1.1.1 The Simpson 360 Digital Volt-Ohm-Milliammeter (hereafter referred to as Simpson 360 or simply as the 360), is a compact, 3-1/2 digit digital multimeter for both portable and laboratory applications. It features 0.25% accuracy, solid state integrated circuit electronics, self-contained AC line and battery operation, and LED display. Additional features are automatic polarity, very good temperature and overranging characteristics, analog indication, and analog (recorder) output.

1.1.2 The 360 measures DC voltage, AC voltage, DC and AC current and resistance as specified in Table 1-1. The dual-slope integration technique is used for the analog-to-digital conversion, because of its inherently excellent stability, accuracy, and noise immunity. The careful use of integrated circuits achieves high reliability, low power dissipation, and a compact design.

1.1.3 The Simpson 360 can be operated from a 120 or 240 volts AC (50 to 400 Hz) power source (check rear panel designation). For applications requiring complete isolation from the power line, or when the AC line is not available, battery operation is provided using rechargeable, nickel-cadmium cells. The battery can operate the Instrument for five hours continuously. Recharging is automatic when the Instrument is in the BATT CHRG ONLY position, and with the line cord connected. In an emergency, commercially available, "C" size (flashlight type) batteries can be used (refer to Section IV for precautions and instructions).

1.1.4 The numerical display is a 7-segment light-emitting-diode (LED) for easy viewing and solid-state reliability. The numerals are 0.33 inch high and in a single plane for distant and wide-angle viewing. Ambient lighting effects are minimized by a filter which reduces reflections and background illumination.

1.1.5 Two "low power" resistance measuring ranges, which feature a maximum open-circuit voltage of 150 millivolts, are provided. These ranges are useful in making resistance measurements in circuits containing semi-conductor devices. The low open-circuit voltage avoids possible damage or "turn-on" of nearly all types of semi-conductor devices.

1.1.6 The recorder output provision makes it possible to record low level high impedance voltage sources using a non-potentiometric recorder.

1.1.7 The analog meter provides quick and convenient indications for nulling, peaking, scanning and varying signal applications.

1.2 ACCESSORIES AND SUPPLIES

All supplies and accessories required for the operation of the Instrument (using line power) are furnished with the Instrument and listed in Table 7-1. Batteries are not supplied.

1.3 TECHNICAL DATA

Table 1-1 lists the technical specifications for the Simpson 360 Digital Volt-Ohm-Milliammeter.

Table 1-1. Technical Data

1. DC Voltage:

Range	Maximum Indication	Input Impedance	Overload Protected To
200 mV	199.9 mV	≧100 MΩ	350 V
2 V	1.999 V	≧1000 MΩ	350 V
20 V	19.99 V	10 MΩ	1000 V
200 V	199.9 V	10 MΩ	1000 V
1000 V	1000 V (max. input)	10 MΩ	1100 V

Accuracy: (from +15°C to +35°C)	± (0.25% of reading + 1 digit)
Input Bias Current:	7 nA maximum at reference conditions
Resolution:	100 microvolts on 200 mV range
Overrange Capability:	Linear to 250 counts beyond maximum indication (except on 1000 V range, where any indication greater than 1100 is an overload)
Temperature Coefficient: (from 0°C to +50°C)	±0.025% of reading +0.1 digit)/C°
Full Scale Step Response: (to within rated accuracy)	2 seconds, maximum
Normal Mode Rejection:	35 dB minimum at 60 Hz
Common Mode Rejection:	80 dB minimum at 60 Hz with 1000 Ω unbalance
	100 dB minimum at DC with 1000 Ω unbalance

2. Resistance:

Range	Maximum Indication	Test Current	Full Scale Voltage	Max. Open Circuit Voltage	Overload Protected To
*200 Ω	199.9 Ω	420 μA	100 mV	150 mV	**250 V rms
*2 kΩ	1.999 kΩ	42 μA	100 mV	150 mV	**250 V rms
20 kΩ	19.99 kΩ	10 μA	200 mV	10 V	250 V rms
200 kΩ	199.9 kΩ	10 μA	2 V	10 V	250 V rms
2 MΩ	1.999 MΩ	1 μA	2 V	10 V	250 V rms
20 MΩ	19.99 MΩ	100 nA	2 V	10 V	250 V rms

Accuracy: (from +15°C to +35°C)	20 kΩ, 200 kΩ and 2 MΩ ranges: ± (0.5% of reading + 1 digit) 200 Ω and 2 kΩ ranges: ± (0.7% of reading + 2 digits) 20 MΩ range: ± (1% of reading + 2 digits)
Resolution:	0.1 ohm on 200 Ω range
Overrange Capability:	Linear to 250 counts beyond maximum indication, except on 200 Ω and 2 kΩ ranges
Temperature Coefficient: (from 0°C to +50°C)	± (.05% of reading + .1 digit)/C°
Full Scale Step Response: (to rated accuracy)	2 seconds, except 6 seconds on the 20 MΩ range
*Low Power Ohms:	Maximum Open Circuit Voltage is 150 mV and maximum power dissipated in the unknown is 100 μW

**Fuse Protected

3. AC Voltage (Average-Sensing, RMS-Calibrated Sine Wave):

Range	Maximum Indication	Input Impedance	Overload Protected To
200 mV	199.9 mV	1 MΩ and 150 pf	350 V rms
2 V	1.999 V	1 MΩ and 150 pf	350 V rms
20 V	19.99 V	1 MΩ and 150 pf	600 V rms
200 V	199.9 V	1 MΩ and 150 pf	600 V rms
600 V	600 V (Max. Input)	1 MΩ and 150 pf	600 V rms

Accuracy: (from +15°C to +35°C)	± (0.5% of reading + 1 digit), 40 Hz to 1000 Hz + (1.0% of reading + 1 digit), 1000 Hz to 10 kHz ± (2.0% of reading + 2 digits), 10 kHz to 20 kHz
Resolution:	100 microvolts on 200 mV range
Overrange Capability:	Linear to 250 counts beyond maximum indication (except on 600 V range, where any indication greater than 600 is an overload)
Full Scale Step Response: (to rated accuracy)	5 seconds max.
Temperature Coefficient: (from 0°C to +50°C)	± (0.05% of reading + 0.1 digit)/C°

4. DC Current:

Range	Maximum Indication	Full Range Voltage Drop	Overload Protected To
20 μA	19.99 μA	200 mV	3 mA
200 μA	199.9 μA	200 mV	25 mA
2 mA	1.999 mA	200 mV	*1/2 Amp
20 mA	19.99 mA	200 mV	*1/2 Amp
200 mA	199.9 mA	200 mV	*1/2 Amp
2 A	1.999 A	200 mV	3 Amps
10 A	10.00 A (max. input)	100 mV	10 Amps

*Fuse Protected

Accuracy: (from +15°C to +35°C)	± (0.5% of reading + 1 digit), except on 2 A and 10 A ranges, which are ± (1.0% of reading + 1 digit)

Resolution:	10 nanoamps on 20 μA range
Overrange Capability:	Linear to 250 counts beyond maximum indication (except on 10 A range, where any indication greater than 1000 is an overload)
Full Scale Step Response: (to rated accuracy)	2 seconds max.
Temperature Coefficient: (from 0°C to +50°C)	± (0.03% of reading + .1 digit)/C°

5. AC Current (40 Hz to 10 kHz)

Range	Maximum Indication	Full Scale Voltage Drop	Overload Protected To
200 μA	199.9 μA	200 mV	25 mA
2 mA	1.999 mA	200 mV	*1/2 Amp
20 mA	19.99 mA	200 mV	*1/2 Amp
200 mA	199.9 mA	200 mV	*1/2 Amp
2 A	1.999 A	200 mV	3 Amps
10 A	10.00 A (max. input)	100 mV	10 Amps

Accuracy: (from +15°C to +35°C)	± (1.0% of reading + 1 digit), except on 2A and 10 A ranges, which are ± (2.0% of reading + 2 digits)
Resolution:	100 nanoamps on 200 μA range
Overrange Capability:	Linear to 250 counts beyond maximum indication (except on 10 A range, where any indication greater than 1000 is an overload)
Full Scale Step Response: (to rated accuracy)	5 seconds max.

Temperature Coefficient: (from 0°C to +50°C)	± (0.05% of reading + .1 digit)/C°

*Fuse Protected

6. Max. Common Mode Voltage: 600 volts (DC plus peak AC) maximum from COMMON terminal to power line ground terminal

7. Display:

Numerical Display:	3-1/2 digits. 7-segment, light-emitting-diode (LED) type, non-blinking with storage
Conversion Rate:	5 readings per second, nominal
Overrange Indication:	Automatic beyond 1999, with lower half of the "1" digit flashing
DC Polarity Selection:	Automatic, with "+" or "−" indication
Analog Display:	Nulling type indicator

8. Analog Output: The function of the ANALOG OUTPUT is to provide for analog monitoring by a chart recorder, or perhaps a companion analog instrument

Level:	1 volt DC with reading of 1000
Output resistance:	100 ohms nominal
Accuracy:	The basic accuracy is that of the overall Instrument on the particular function and range being used, plus an additional possible error no greater than ±2% of maximum reading

9. Power Requirement:

a. AC Operating or Battery Charging:	120 VAC or 240 VAC ±10% (check rear panel designation), 50 to 400 Hz
b. Battery Operation:	Four nickel-cadmium "C" size rechargeable cells, GE Cat. No. GCT 1.5 SB or Eveready CH 1.8. Caution: Overall battery length must not exceed 1.940 inches.
c. Operation time (continuous) with fully charged battery:	5 hours nominal
d. Recharge time (function switch in BATT CHRG ONLY position):	16 hours nominal
e. Recharge time (while Instrument is in operation):	30 hours nominal

10. Temperature Range:

Operating:
0°C to +50°C

Storage: −40°C to +60°C

11. Reference Conditions:

Temperature:
+25°C ±1°C

Relative Humidity: 30 to 60%

Atmospheric Pressure: 575 to 800 mm Hg

12. Weight (with battery): 4.5 pounds

13. Dimensions: 7.2" high, 5.4" wide, 2.75" deep (not including panel controls)

SECTION II

INSTALLATION

2.1 UNPACKING AND INSPECTION

2.1.1 Examine the shipping carton for signs of damage prior to unpacking. If there is none, then unpack and inspect the Instrument for possible damage in shipment. Check the electrical performance as soon as possible. If damage is noted, notify the carrier and supplier before using the Instrument. Also check that all items are included (Table 7-1).

2.1.2 Save the shipping carton and packing materials for future storing or shipping of the Instrument.

2.2 POWER SOURCE REQUIREMENTS

CAUTION

Do not insert power cord plug into the power source yet. Check that the designation on the rear panel agrees with the power source to be used.

2.2.1 The Simpson 360 is designed to be operated from either

the AC line or self-contained nickel-cadmium cells (not furnished with the Instrument). Refer to Table 1-1.

2.2.2 AC Line Operation: The Simpson 360 is wired at the factory for 120 VAC (50 to 400 Hz) operation. For 240 VAC operation, consult your nearest Simpson Authorized Service Center.

WARNING

For AC line operation, insure that the grounding pin of the power plug is securely connected to an earth (power line) ground. Preferably, use a 3-wire grounded outlet which conforms to the latest electrical code.

2.2.3 Battery Operation:

a. The Simpson 360 is supplied without batteries. The cells required (refer to Table 1-1, item 9), usually can be purchased from a local electronic parts distributor.

b. Battery operation is automatic whenever cells are installed, the line cord is disconnected, and the function switch is set in the DC, OHMS or AC position.

c. For battery installation and battery test refer to paragraph 6.5.

2.3 INSTALLATION

The Instrument may be operated in any position. It can be inclined conveniently by positioning the Adjust-A-Vue Handle.

SECTION III

CONTROLS, CONNECTORS AND INDICATORS

3.1 GENERAL

All operating and adjustment controls, connectors, and indicators are described in Table 3-1. Become familiar with each item prior to operating the Instrument for the first time.

3.2 FRONT AND REAR PANEL DESCRIPTION

Table 3-1 lists all front and rear panel controls, connectors and indicators (see Figure 3-1 for identification).

Table 3-1. Front and Rear Panel Description

1. Function Selector Switch

Switch Position	Description
BATT CHRG ONLY	Connects the circuit to fully charge the battery in 16 hours nominal when the AC line cord is connected to the recommended line voltage. The panel LED lights when the switch is in this position.
OFF	Disconnects all power from the internal circuits.
DC, OHMS	Connects the appropriate jacks to the DC voltage, DC current, or resistance measuring circuits, depending on the range switch position setting.
AC	Connects the appropriate jacks to the AC voltage or AC current measuring circuits, depending on the range switch position setting.

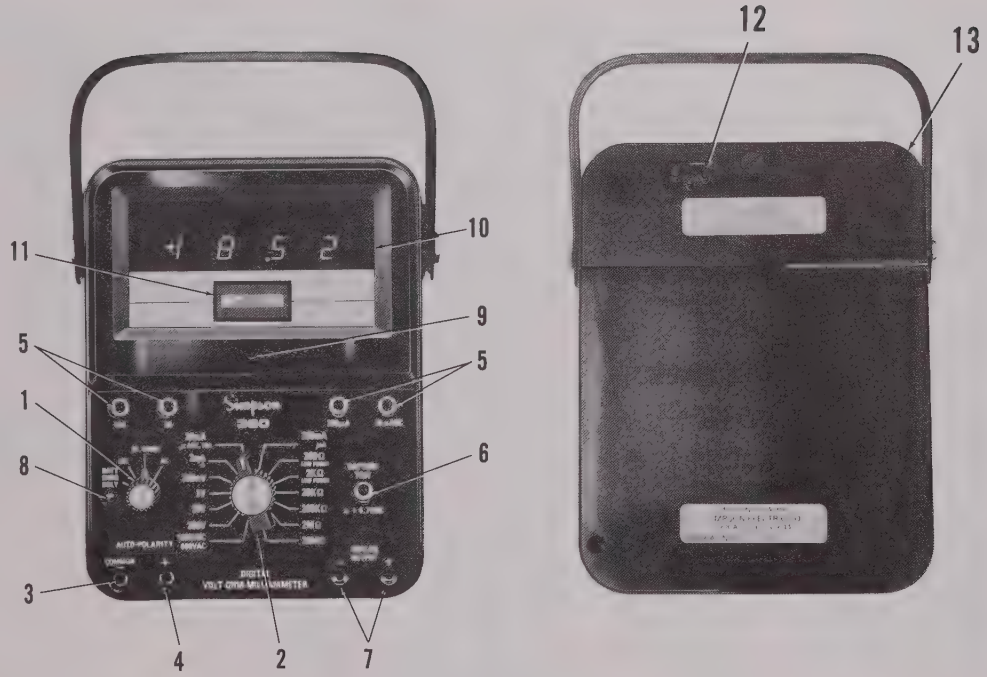

Figure 3-1. Front & Rear Panel Description

2. Range Selector Switch

Switch Position	Description
200mV, 2V, 20V, 200V and 1000 VDC 600 VAC	Selects the desired range setting of DC volts (either polarity) or AC volts, depending on the function switch position setting. The input voltage is applied at the + and COM MON jacks.
200 Ω LOW POWER and 2K Ω LOW POWER	Selects the circuits required for the measurement of resistance from "0" to 200 Ω or 2 kΩ, when the function switch is set to DC, OHMS position, and the input signal leads are connected to the + and COMMON jacks. The two LOW POWER resistance ranges have a maximum open-circuit voltage of approximately 150 mV.
20KΩ, 200KΩ, 2MΩ, and 20MΩ	Selects the circuits required for the measurement of resistance from "0" to the corresponding range setting of KΩ or MΩ, when the function switch is set to DC, OHMS position, and the input signal leads are connected to the + and COMMON.
2mA A	Selects the circuits required for the measurement of AC and DC current as follows:

Range	Function Switch Position	Input Connection
0 to ±2mA DC 0 to 2mA AC	DC, OHMS AC	+ and COMMON jacks
0 to ±2mA DC 0 to 2A AC	DC, OHMS AC	2A and COMMON jacks

20mA μADC, 10A — Selects the circuits required for the measurement of AC and DC current as follows:

Range	Function Switch Position	Input Connection
0 to ±20mA DC 0 to 20mA AC	DC, OHMS AC	+ and COMMON jacks
0 to ±20μA DC	DC, OHMS	20μA DC and COMMON jacks
0 to ±10A DC 0 to 10A AC	DC, OHMS AC	10A and COMMON jacks

200mA
μA — Selects the circuits required for the measurement of current as follows:

Range	Function Switch Position	Input Connection
0 to ±200mA DC 0 to 200mA AC	DC, OHMS AC	+ and COMMON jacks
0 to ±200μA DC 0 to 200μA AC	DC, OHMS AC	200μA and COMMON jacks

3. COMMON jack

This jack is used to connect the "low" side of the circuit being measured to the internal circuit ground and is isolated from the AC power line ground.

WARNING

Do not "float" this terminal more than 600 volts (DC plus AC peak) away from power line ground.

4. + jack

This terminal is used to connect the "high" side of the circuit being measured to all voltage, resistance, and some current measuring circuits through the range and function switches.

5. 20μA DC, 200μA, 2A and 10A Current Jacks

These terminals are used to connect the "high" side of the currents being measured and provide ranges of 0 to 20μA DC, 200μA AC or DC, 2A AC or DC, and 10A AC or DC, depending on the position settings of the function and range switches. The "low" side is connected to the COMMON jack.

6. BATTERY TEST jack

This jack connects the positive terminal of the battery (through an isolation resistor) when the internal battery is installed. For battery test, a test lead is connected between the + jack and the BATTERY TEST jack, with the function selector switch set in the DC, OHMS position and the range selector switch set in the 20V position. The numerical display must indicate greater than +4.70 volts for proper Instrument operation.

7. ANALOG OUTPUT, + and − Jacks

The signal from these jacks is a DC voltage which is directly proportional to the input signal, and whose value is 1 volt when the digital display indicates 1000 counts. These jacks accept test leads with insulated pin tip plugs, H. H. Smith type 491 or equivalent. See Table 1-1 for specifications.

8. Battery Charge Indicator

The light-emitting diode next to the function switch indicator illuminates when the function selector switch is set to the BATT CHRG ONLY position, with the AC line cord connected. The indicator is used to indicate charging of the battery.

9. Zero Adjustment

The zero adjustment is a screwdriver adjusted potentiometer used to correct for a DC offset voltage at the input to the integra-

tor/amplifier. It is adjusted to obtain a numerical indication of 000 when the input terminals are shorted together, with the function switch set on DC, OHMS and the range selector switch set on the 2KΩ LOW POWER position.

10. Numerical Display

The digital display uses LED's and includes a polarity (+, −) sign, a "1" digit, and three 7-segment type 0 to 9 digits and a decimal point, to indicate the polarity and the value of the signal being measured. The decimal point is properly positioned by the setting of the range selector switch. When an "overrange" condition exists. the lower half of the "1" digit will flash.

11. Analog Display

This indicator has zero at its center. In conjunction with the position setting of the range switch, it displays in analog form the relative value of the input signal being measured. An indicator of this form can be very helpful when one is adjusting a circuit for a peak or a null.

12. AC Power Receptacle

This receptacle accepts the AC line power cord used for AC operation or battery charging.

CAUTION

Be sure AC power source used matches power requirements designated on rear of Instrument.

13. Battery and Fuse Compartment Cover

This cover is removed (after disconnecting the line cord) when installing the batteries, or when changing the LINE, OHMS, and CURRENT fuses. One set of spare fuses is provided inside the compartment.

WARNING

Do not reconnect the line cord to the Simpson 360 with the Battery and Fuse Compartment removed.

SECTION IV

OPERATION

4.1 GENERAL

WARNING

The Simpson 360 is designed to prevent accidental shock when properly used. However, no engineering design can render safe an instrument which is used carelessly. Therefore, this manual must be read carefully and completely prior to making any measurements. Failure to do so can result in a serious or fatal accident.

This section of the manual contains all the information required to use and operate the 360 in a safe and proper manner. Special notes and instructions have also been provided for added user safety, and convenience.

4.2 SAFETY PRECAUTIONS

4.2.1 The Simpson 360 is designed to be used only by personnel qualified to recognize shock hazards and trained in the safety precautions required to avoid possible injury. Refer to SHOCK HAZARD definition on page v.

4.2.2 Do not work alone when making measurements where a shock hazard can exist. Notify another person that you are, or intend to make such measurements.

4.2.3 Remember, voltages might appear unexpectedly in defective equipment. An open bleeder resistor can result in a capacitor's retaining a dangerous charge. Remove all power and discharge all capacitors in the circuit being measured and remove all power from the Simpson 360 *before* making connections or disconnections. The Instrument itself is well protected against electrical overload, as noted throughout Section 1.3. However, the above precautions are wise even in the laboratory, and especially in field usage of the Instrument where many strange or unknown safety hazards might prevail.

4.2.4 Locate all voltage sources and accessibility paths prior to making any measurement or connections.

4.2.5 For your own safety, inspect the test leads for cracks, breaks or crazes in the insulation prods and connectors before each use. If any defects exist, destroy and replace the defective item(s) immediately.

4.2.6 Do not make measurements in a circuit where corona is present. Corona can be identified by a pale-blue color emanating from sharp metal points in the circuit or a buzzing sound, or the odor of ozone. In rare instances, such as around germicidal lamps, ozone might be generated as a normal function. Ordinarily, the presence of ozone indicates presence of high voltage, and probably a malfunction of some kind.

4.2.7 Hands, shoes, floor and workbench must be dry. Avoid making measurements under humid, damp, or other environmental conditions that could affect the dielectric withstanding voltage of the test leads or the Instrument.

4.2.8 For maximum safety, do not touch test leads, circuit, or Instrument while power is applied to the circuit being measured.

4.2.9 Use extreme caution when making measurements in an rf circuit where a dangerous combination of voltages could be present, such as in a modulated rf amplifier.

4.2.10 Do not use test leads which differ from those originally furnished with the Instrument.

4.2.11 Before the Instrument is used for AC operation, make sure that the "third wire" on the AC power cord is connected to an earth or power line ground.

4.2.12 Do not float the COMMON terminal more than 600 volts (DC plus AC peak) with respect to the power line ground.

4.3 PRELIMINARY NOTES AND CHECKS

Prior to operation of the Instrument, review and perform (where

applicable) the following notes and checks. These steps can be used also as a general functional check.

4.3.1 For AC line operation, insure that the power source used matches the requirements of the Instrument as marked on the rear panel and insert the plug into a 3-wire power outlet which conforms to the latest electrical code. The Instrument will operate with or without battery. When the Instrument is operating on the AC line with the internal battery installed, the battery is being "trickle" charged.

CAUTION

Do not operate the Instrument with cells in the completely discharged state, which is common for all new cells as acquired from the vendor. See paragraph 6.6.

4.3.2 Battery Operation:

a. Disconnect the AC line cord and set the function selector switch to the OFF position. Install four "C" size nickel-cadmium cells (not supplied with Instrument). Observe polarity as shown on label inside battery holder.

b. Set the range selector switch to the 20V position.

c. Set the function selector switch to the DC, OHMS position.

d. Connect a test lead between the + jack (lower left corner) and the BATTERY TEST jack. The reading must be greater than +4.7 volts for proper operation of the Instrument.

e. If the battery voltage is below +4.7 volts, or if the display does not emit light, either the battery is improperly installed or recharging is required.

4.3.3 To recharge the battery:

Refer to paragraph 6.6 for recharging procedure.

4.3.4 For a general functional check, this procedure:

a. Connect the black test lead to the COMMON jack and the red test lead to the + jack. Short the test leads together.

b. Turn the function selector switch to the DC, OHMS position, and the range selector switch to the 200mV position. The display will indicate 00.0 with the polarity sign alternating between "−" and "+".

c. Open the test leads. The numerical display will advance (due to input bias current) from 00.0 to −199.9, and into overrange. Now the lower half of the numeral "1" will flash, indicating overrange.

d. Short the test leads together. The display reading will return to 00.0.

e. If difficulty is encountered in the above steps, see Section VI, paragraph 6.9 for Zero Adjustment procedure.

4.3.5 On AC line operation, do not "float" the Instrument above power line ground more than 600 volts (DC plus AC peak).

4.4 DC VOLTAGE MEASUREMENT

WARNING

Prior to making measurements, review and comply with the SAFETY PRECAUTIONS listed in paragraph 4.2.

4.4.1 Review and comply with the Preliminary Notes and Checks, paragraph 4.3.

4.4.2 Connect input test leads to the + and COMMON terminals.

4.4.3 Turn the function selector switch to the DC, OHMS position.

4.4.4 Turn the range selector switch to the appropriate voltage range position as indicated in Table 4-1. If the voltage being measured is unknown, begin with the range selector switch set to the 1000 VDC position.

4.4.5 Turn off the power to the device or circuit under test, and discharge all capacitors.

CAUTION

Do not attempt to measure voltages on the 1000 VDC range which might be greater than 1100 volts DC.

4.4.6 Connect test leads to the circuit being measured.

4.4.7 Apply power to the circuit being measured. The Instrument will automatically indicate the correct polarity. The value of the voltage being measured will be indicated on the numerical display. The analog display will indicate the relative value and can be used for nulling or peaking applications.

4.4.8 Remove all power from the circuit being measured, discharge all capacitors, and disconnect test leads.

Table 4-1. DC Voltage Ranges and Connections

Range	Range Switch Position	Function Switch Position	Input Connections	Max. Voltage	Remarks
0 to 200 mV	200 mV	DC, OHMS	+ and COMMON jacks	350V	Auto-Polarity
0 to 2 V	2V	DC, OHMS	+ and COMMON jacks	350 V	Auto-Polarity
0 to 20 V	20V	DC, OHMS	+ and COMMON jacks	1100 V	Auto-Polarity
0 to 200 V	200V	DC, OHMS	+ and COMMON jacks	1100 V	Auto-Polarity
0 to 1000 V	1000V	DC, OHMS	+ and COMMON jacks	1100 V	Auto-Polarity

4.5 AC VOLTAGE MEASUREMENT

WARNING

Prior to making measurements, review and comply with the SAFETY PRECAUTIONS listed in paragraph 4.2.

4.5.1 Review and comply with the Preliminary Notes and Checks, paragraph 4.3.

4.5.2 Connect input test leads to the + and COMMON terminals.

4.5.3 Turn the function selector switch to the AC position.

4.5.4 Turn the range selector switch to the appropriate voltage range position, as indicated in Table 4-2. If the voltage being measured is unknown, begin with the range selector switch set to the 600 VAC position.

CAUTION

Do not attempt to measure voltages on the 600V range which might be greater than 600 volts.

4.5.5 Remove all power from the circuit being measured and discharge all capacitors.

4.5.6 Connect test leads to the circuit being measured.

4.5.7 Apply power to the circuit being measured. The value of the voltage being measured will be indicated on the numerical display. The analog display can be used for nulling or peaking applications.

4.5.8 Remove all power from the circuit being measured, discharge all capacitors, and disconnect test leads.

4.6 RESISTANCE MEASUREMENT

4.6.1 Review and comply with the Preliminary Notes and Checks, paragraph 4.3.

4.6.2 Connect input test leads to the + and COMMON terminals.

4.6.3 Turn the function selector switch to the DC, OHMS position.

4.6.4 Turn the range selector switch to the appropriate resistance range position as indicated in Table 4-3.

Table 4-2. AC Voltage Ranges and Connections

Range	Range Switch Position	Function Switch Position	Input Connections	Max. Voltage	Remarks
0 to 200 MV	200mV	AC	+ and COMMON jacks	350 V rms	
0 to 2 V	2V	AC	+ and COMMON jacks	350 V rms	Frequency Range: 40 Hz to 20 kHz for all range positions
0 to 20 V	20V	AC	+ and COMMON jacks	600 V rms	
0 to 200 V	200V	AC	+ and COMMON jacks	600 V rms	
0 to 200 V	200V	AC	+ and COMMON jacks	600 V rms	
0 to 600 V	600V	AC	+ and COMMON jacks	600 V rms	

Table 4-3. Resistance Ranges and Connections

Range	Range Switch Position	Function Switch Position	Input Connections	Test Current	Max. Open-Circuit Voltage	Remarks
0 to 200 Ω	200Ω LOW POWER	DC, OHMS	+ and COM-MON jacks	420 μA	150 mV	Low Power
0 to 2 kΩ	2KΩ LOW POWER	DC, OHMS	+ and COM-MON jacks	42 μA	150 mV	Low Power
0 to 20 kΩ	20KΩ	DC, OHMS	+ and COM-MON jacks	10μA	10 V	
0 to 200 kΩ	200KΩ	DC, OHMS	+ and COM-MON jacks	10 μA	10 V	
0 to 2 MΩ	2MΩ	DC, OHMS	+ and COM-MON jacks	1 μA	10 V	
0 to 20 MΩ	20MΩ	DC, OHMS	+ and COM-MON jacks	100 nA	10 V	

4.6.5 If the resistance being measured is connected into a circuit, *be certain that all power is removed from the circuit and all capacitors are discharged.* Check for alternate resistance paths other than the resistance being measured. These paths can result in a measured value which is lower than the actual value of the resistance being measured.

4.6.6 Connect the test leads to the resistance being measured. Be careful not to contact adjacent points, even if insulated, particularly when making high resistance measurements. Some insulators can have relatively low insulation resistance, which can sufficiently shunt the resistance being measured to result in a measured value lower than the presumed and actual value.

NOTE: If the resistance being measured is polarity or voltage sensitive (for example, semiconductors), careful considerations must be given when making connections and selecting the resistance range (refer to Table 4-3).

4.6.7 Allow time for the display to stabilize. This is especially important when measuring a high value resistance shunted by a large value of capacitance.

4.6.8 Disconnect test leads.

4.6.9 If no additional, immediate resistance measurements are required, rotate the range selector switch to the 1000 VDC 600 VAC position and the function selector switch to the OFF position. These settings avoid the possibility of accidentally applying voltage to the resistance circuits, and causing the internal protective fuse to open.

4.7 DC CURRENT MEASUREMENT

WARNING

Prior to making measurements, review and comply with the SAFETY PRECAUTIONS listed in paragraph 4.2.

4.7.1 Review and comply with the Preliminary Notes and Checks, paragraph 4.3.

4.7.2 Turn the function selector switch to the DC, OHMS position.

4.7.3 Turn the range selector switch to the appropriate current range position as indicated in Table 4-4. If the current being measured is unknown (but less than 10 A), begin with the range selector switch set to the 20mA, μADC, 10A position and connect the red test lead to the 10 A jack and the black test lead to the COMMON jack.

4.7.4 Remove all power to the circuit being measured and discharge all capacitors.

4.7.5 Connect the test leads according to Table 4-4.

4.7.6 Open the circuit in which the current is to be measured and connect the test leads in series. Insure that the Simpson 360 is not connected across a voltage source which can exceed the range setting of the Instrument.

Table 4-4. DC Current Ranges and Connections

Range	Range Switch Position	Function Switch Position	Input Connections	Max. Current	Remarks
0 to 20 μA	μADC, 10A 20 mA	DC, OHMS	20μADC and COMMON jacks	3 mA	Auto-Polarity on all ranges
0 to 200 μA	200mA μA	DC, OHMS	200μA and COMMON jacks	25 mA	
0 to 2 mA	2 mA A	DC, OHMS	+ and COMMON jacks	*1/2 Amp	
0 to 20 mA	20 mA μADC, 10A	DC, OHMS	+ and COMMON jacks	*1/2 Amp	
0 to 200 mA	200mA μA	DC, OHMS	+ and COMMON jacks	*1/2 Amp	
0 to 2 A	2mA A	DC, OHMS	2A and COMMON jacks	3 Amps	
0 to 10 A	20 mA μADC, 10A	DC, OHMS	10A and COMMON jacks	10 Amps	

*Fuse Protected

4.7.7 Apply power to the circuit being measured.

4.7.8 The value of the current being measured is indicated on the numerical display. The analog display can be used for nulling or peaking applications.

4.7.9 Remove all power from the circuit being measured and discharge all capacitors.

4.7.10 Disconnect the test leads and reconnect the circuit which was originally opened.

4.7.11 If no additional, immediate current measurements are required, rotate the range selector switch to the 1000 VDC 600 VAC position and the function selector switch to the OFF position. These settings avoid the possibility of accidentally applying voltage to the current circuits, which can cause damage to the Instrument.

4.8 AC CURRENT MEASUREMENT

WARNING

Prior to making measurements, review and comply with the SAFETY PRECAUTIONS listed in paragraph 4.2.

4.8.1 Review and comply with the Preliminary Notes and Checks, paragraph 4.3.1.

4.8.2 Turn the function selector switch to the AC position.

4.8.3 Turn the range selector switch to the appropriate current range position as indicated in Table 4-5. If the current being measured is unknown (but less than 10 A), begin with the range selector switch set to the 20mA, μADC, 10A position and connect the red test lead to the 10 A jack. Connect the black test lead to the COMMON jack.

4.8.4 Remove all power from the circuit being measured and discharge all capacitors.

4.8.5 Open the circuit in which the current is to be measured

and connect the test leads in series. Insure that the Simpson 360 is not connected across a voltage which can exceed the range setting of the Instrument.

4.8.6 Connect the test leads according to Table 4-5.

Table 4-5. AC Current Ranges and Connections

Range	Range Switch Position	Function Switch Position	Input Connections	Max. Current	Remarks
0 to 200 μA	200mA μA	AC	200 μA and COMMON jacks	25 mA	Frequency Range: 40 Hz to 10 kHz
0 to 2 mA	2mA A	AC	+ and COMMON jacks	*1/2 Amp	*Fuse
0 to 20 mA	20mA μADC, 10A	AC	+ and COMMON jacks	*1/2 Amp	Protected
0 to 200 mA	200mA μA	AC	+ and COMMON jacks	*1/2 Amp	
0 to 2A	2mA A	AC	2A and COMMON jacks	3 Amps	
0 to 10 A	20mA μADC, 10A	AC	10A and COMMON jacks	10 Amps	

4.8.7 Apply power to the circuit being measured.

4.8.8 The value of the current being measured is indicated on the numerical display. The analog display can be used for nulling or peaking applications.

4.8.9 Remove all power from the circuit being measured and discharge all capacitors.

4.8.10 Disconnect the test leads and reconnect the circuit which was originally opened.

4.8.11 If no additional, immediate current measurements are required, rotate the range selector switch to the 1000 VDC 600 VAC

position and the function selector switch to the OFF position. These settings avoid the possibility of accidentally applying voltage to the current circuits, which can cause damage to the Instrument.

4.9 OPERATION WITH RECORDERS

4.9.1 The ANALOG OUTPUT terminals of the Simpson 360 may be connected to the input terminals of a graphic recorder. Operational information of the particular recorder is covered in the Operator's Manual for the recorder.

4.9.2 The ANALOG OUTPUT terminals provide 1 volt DC (open circuit), corresponding to a digital indication of 1000, with a nominal resistance of 100 ohms. This output is sufficient for use with general purpose, non-potentiometric recorders. Hence, it offers capabilities not otherwise possible in a low-cost package.

4.9.3 The Simpson 360 provides isolation for the recorder (10 MΩ on DC volts, 1 MΩ on AC volts), combined with the numerous functions of AC/DC volts, resistance and AC/DC current.

4.9.4 The Simpson Models 603 (Cat. No. 20201), 604 (Cat. No. 12610), and 2750 (Cat. No. 22002) are excellent examples of low cost recorders which can be used with the Simpson 360.

4.9.5 The Model 604 has a 2.5 VDC range and can be used directly with the Simpson 360. The loading effect of the 604 will be less than 0.25%.

4.9.6 The Models 603 and 2750 specified in paragraph 4.9.4 are basically 0 to 50 μA DC instruments and will require a series multiplier resistance to convert the recorder to a 2 volt or 2.5 volt instrument. Since the standard chart paper markings for the recorders are 50 divisions, a 2.5 volt range is recommended.

NOTE: On other than the 1000 VDC 600 VAC ranges, the Simpson 360 has measurement capability beyond an indication of 1999. It is linear to an equivalent indication of 2250.

4.9.7 The series multiplier resistance required will be approximately 50 kΩ, minus the recorder resistance (1000 to 2000Ω, typically). To allow for the accuracy of the recorder, the series multiplier should be made of a fixed resistor, plus a variable resistor. A fixed resistance of 45,000 ohms, and a 0-10 kΩ variable resistance will suffice for either recorder. The following procedure is used for setting up either recorder.

1. Connect the Simpson 360 to the Model 2750 or Model 603 recorder, and a 0 to 2 VDC voltage source as shown in Figure 4-1.
2. Adjust the output of the 0 to 2 VDC voltage source for an indication of 1.950 on the 360.
3. Adjust the 10 kΩ variable resistance for an indication on the recorder chart paper of 39 divisions.
4. The recorder is now calibrated to the Simpson 360. Each division marking on the recorder chart paper equals 50 counts on the Simpson 360 digital display. Therefore, 39 divisions equals 1950 counts. The decimal point location and units being measured are determined by the Simpson 360 function and range selection.

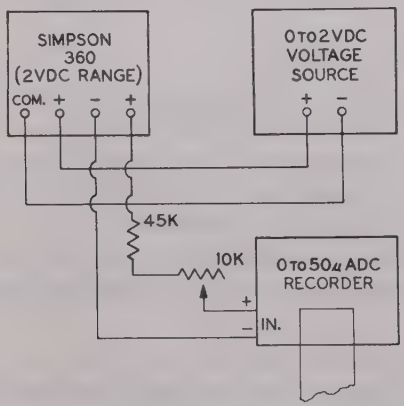

Figure 4-1. Connections For Use of the Model 603, or 2750 Recorder With the Simpson 360

SECTION V

THEORY OF OPERATION

5.1 OVERALL SYSTEM

5.1.1 The basic system diagram for the Simpson 360 is shown in Figure 5-1.

5.1.2 The parameter being measured is connected to the appropriate input terminals. The corresponding Range, Function and Signal Conditioning Circuits convert this parameter into a proportional and numerically equal DC voltage.

5.1.3 This DC voltage is applied to a 3-1/2 digit, bipolar (dual polarity) DC Digital Voltmeter circuit. The measured voltage is indicated on both a 7-segment LED type numerical display and an analog display. The indicated value is equal to the magnitude of the parameter being measured. The measured voltage is also available as a proportional DC voltage, available at the ANALOG OUTPUT jacks.

5.1.4 The Power Supply provides the AC and DC operating voltages required by the signal conditioning and digital voltmeter circuits, and the charging circuit for the rechargeable battery.

5.2 INPUT CIRCUITS

5.2.1 DC Voltage Measurements. The basic DC voltage measurement circuit is shown in Figure 5-2, (a).

5.2.2 The DC voltage being measured is connected to the + and COMMON jacks, attenuated according to the range selected, and measured by the digital voltmeter circuit.

5.2.3 The digital voltmeter circuit provides two basic full range sensitivities: 200mV and 2V. This feature simplifies the attenuator design.

a. No attenuation is required on the 200mV and 2V ranges. The range changing on these two ranges is accomplished by changing the digital voltmeter sensitivity.

Figure 5-1. Basic System Diagram

b. The same attenuator is used on the 20V and 200V ranges.

NOTE: A separate attenuator tap is provided for the 1000 volt range.

5.2.4 AC Voltage Measurements. The basic AC voltage measurement circuit is shown in Figure 5-2, (b).

5.2.5 The AC voltage being measured is connected to the + and COMMON jacks, attenuated according to the range selected, and applied to an Input Amplifier. The output of the amplifier is converted into DC by an AC to DC Converter, and the resulting DC voltage is measured by the DC Digital Voltmeter.

5.2.6 The attenuator is not used on the 200mV and 2V ranges. On the higher ranges, the attenuator is frequency-compensated to provide good accuracy over a wide frequency range (refer to Table 1-1, item 3).

5.2.7 The Input Amplifier achieves a high input impedance and presents a low output impedance to the converter.

5.2.8 The AC to DC Converter uses a half-wave operational amplifier/rectifier circuit which provides two basic full range sensitivities: 200mV and 2V. It is average-responding, but its calibration (gain) is based on the rms value of a sine wave.

5.2.9 The output of the Operational Amplifier has two rectifying diodes and two feedback resistors. R_1 and R_2. These components drive a summing resistor R_3. The junction of the summing resistor and feedback resistors is connected to the amplifier input to provide negative feedback. With a sinewave input signal, the positive half cycles of the output waveform go through one diode, and the negative half cycles through the other diode. The positive half cycle is filtered and the resulting DC voltage is measured by the DC Digital Voltmeter circuit.

5.2.10 The indications on the numerical display are calibrated to the rms sine wave value being measured.

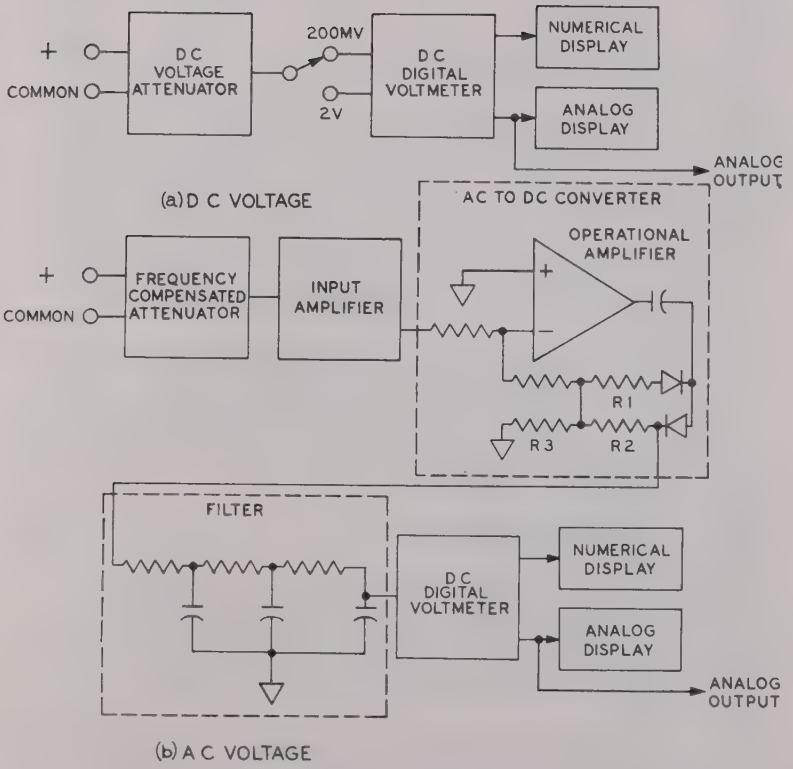

Figure 5-2. Basic Voltage Measurement Circuits

5.2.11 AC Current Measurements. The basic AC current measurement circuit is essentially the same as the DC current measurement circuit (refer to 5.2.12), except that the voltage developed across the internal shunt resistance is measured by the AC voltage measurement circuit.

5.2.12 DC Current Measurements. The basic DC current measurement circuit is shown in Figure 5-3, (a).

5.2.13 The current being measured is connected in series with the COMMON and appropriate jack and an internal precision shunt resistance. The value of the shunt resistance depends on the current range used and is selected so that the voltage developed across it is proportional and numerically equal to the current through it. The digital voltmeter circuit measures this voltage, and the value indicated on the numerical display is equal to the current being measured.

5.2.14 The full range sensitivity of the digital voltmeter circuit measurements is 200mV. Therefore, the internal resistance for each current range equals 200mV divided by the full range current. For example, if the full range current is 200 μA, then the internal resistance would be 1000 ohms.

5.2.15 Resistance Measurements. The basic resistance circuit is shown in Figure 5-3, (b).

5.2.16 The resistance being measured, R_x, is connected to the + and COMMON jacks and a constant current is applied through it by the Instrument. The resulting voltage is proportional to the value of R_x. The value of the current is determined by the resistance of the range selected.

5.2.17 The current through R_x is controlled by an Operational Amplifier whose inputs "follow" E_x and the output is always $E_x + 1$ volt. The 1 volt reference for the amplifier is developed by the current from a Constant Current Source through a 1 kΩ feedback resistor.

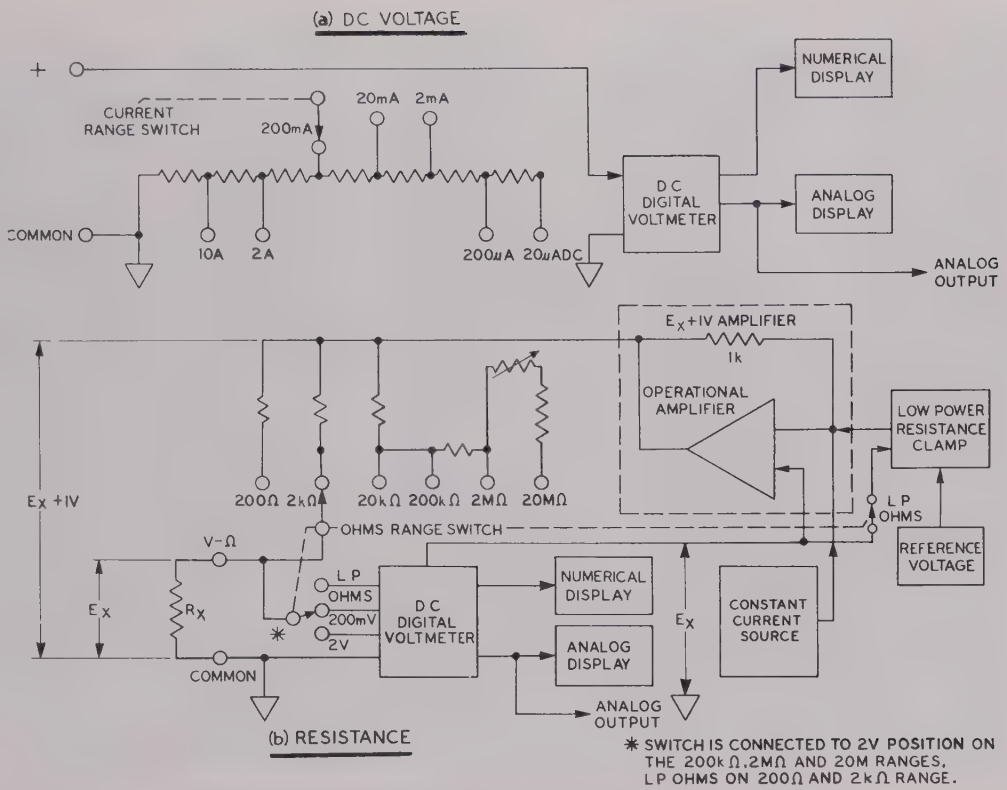

Figure 5-3. Basic DC Current and Resistance Measurement Circuits

5.2.18 The E_x + 1 volt output of the amplifier maintains a constant current through R_x, regardless of the value of R_x. The magnitude of the current is determined by the resistance (precision resistors selected by the ohms range switch) in series with R_x.

5.2.19 The digital voltmeter measures the voltage developed across R_x, and the value indicated on the numerical display is equal to the resistance of R_x.

5.2.20 When the Instrument is set for LOW POWER resistance measurements (either the 200Ω and 2kΩ range), the voltage across the input terminals is limited to 150mV (open-circuit voltage) by the Low Power Resistance Clamp (see Fig. 5-3). This feature limits the power applied to the resistance being measured to less than 100 μW.

5.3 DIGITAL VOLTMETER CIRCUIT

5.3.1 The basic block diagram of the digital voltmeter circuit is shown in Figure 5-4. The circuit utilizes the dual-slope integration technique for the analog-to-digital conversion. This technique achieves excellent accuracy, stability, and noise immunity. The term "dual-slope" is derived from the two slope operation of the integrator.

5.3.2 The incoming DC voltage is sampled and measured at the input of the integrator at typically 5 times per second. The sampling interval, T1, is initiated by a pulse from the Zero Detector circuit, and the measuring interval, T2, by an "overflow" pulse from the Counter Circuits. See Figure 5-5 for the basic timing diagram (shown for a positive input signal).

5.3.3 During T1, the integrating capacitor charges and the Integrator output voltage increases in accordance with the polarity and magnitude of the input signal. At the same time, the Counter Circuits are counting the pulses generated by the 40 kHz Clock Oscillator. At a count of 8000, an "overflow" pulse is generated by the Counter Circuits and the counters reset to the "zero" state.

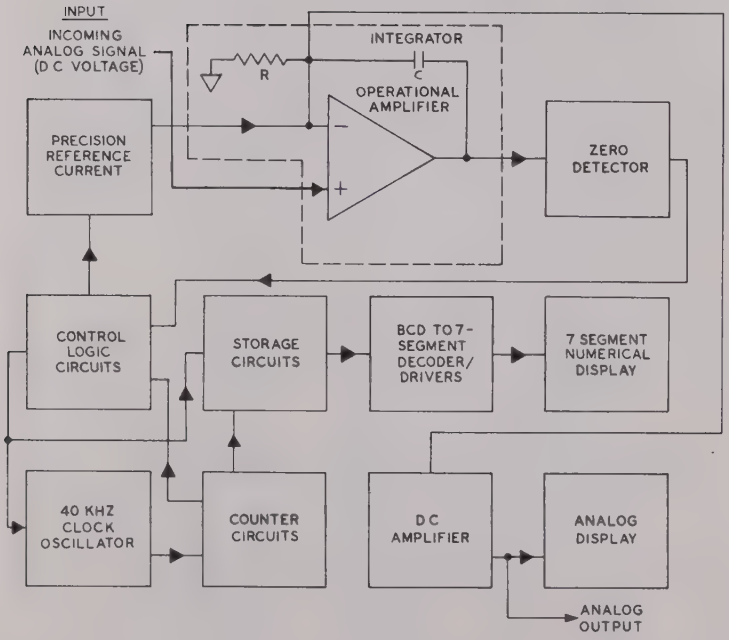

Figure 5-4. Digital Voltmeter, Block Diagram

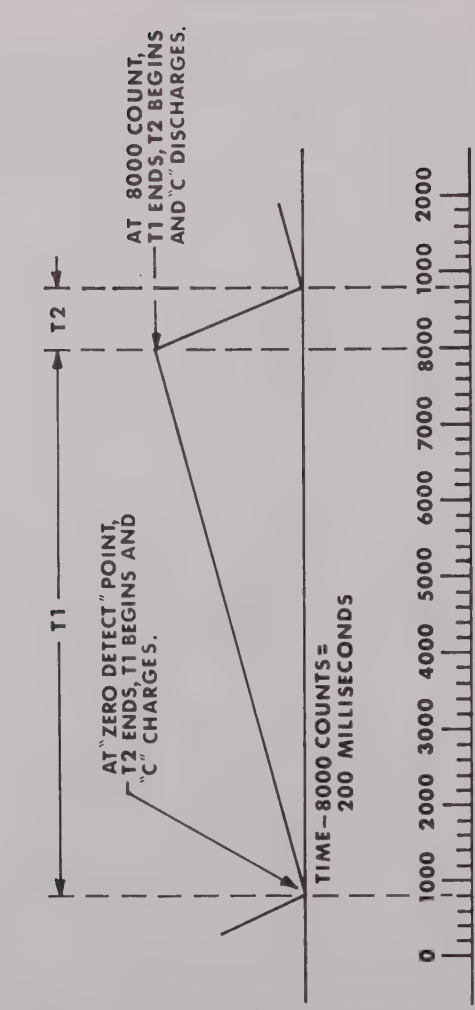
CAPACITOR VOLTAGE
T1
T2
AT "ZERO DETECT" POINT, T2 ENDS, T1 BEGINS AND "C" CHARGES.
AT 8000 COUNT, T1 ENDS, T2 BEGINS AND "C" DISCHARGES.
TIME–8000 COUNTS= 200 MILLISECONDS
0 1000 2000 3000 4000 5000 6000 7000 8000 1000 2000
40 kHZ CLOCK PULSES
PULSE GENERATED BY ZERO DETECTOR
OVERFLOW PULSE GENERATED

Figure 5-5. Simpson 360, Basic Timing Diagram

5.3.4 The "overflow" pulse actuates the Control Logic Circuit which selects a Precision Current Reference of proper polarity and connects it to the Integrator input. At this time, the first integrating interval, T1, is ended, and the second integrating interval, T2, starts.

5.3.5 During T2, the reference current causes capacitor C to discharge, and the voltage at the output of the Integrator to decrease towards zero. At the same time, the Counter Circuits are counting the pulses generated by the 40 kHz clock. The counting continues until the Integrator output reaches zero. At cross-over of zero, the Zero Detector generates a pulse, which, through the Control Logic Circuits, momentarily stops the clock oscillator and transfers the accumulated count to the Storage Circuits as an equivalent BCD signal. The second integrating interval, T2, is now ended, the reference current is disconnected and the cycle repeats (T1 starts).

5.3.6 The BCD to 7-segment Decoder/Drivers convert the accumulated count (BCD signal) into suitable signals for driving a 7-segment LED numerical display. The numerical polarity indications are equal to the value of the analog signal at the input of the Integrator.

5.3.7 The other requirements of the digital voltmeter circuit such as overrange, out-of-range, and polarity indications are accomplished by the Control Logic and Counter Circuits.

5.4 POWER SUPPLY CIRCUITS

5.4.1 The basic block diagram for the 360 power supply circuits is shown in Figure 5-6.

5.4.2 When the Simpson 360 is operated from an AC power line, the incoming AC power is applied to transformer T1. The two primary windings are connected in series for 240 volt (nominal), and in parallel for 120 volt (nominal) operation. T1 steps down the voltage as required by the Rectifier Circuit.

Figure 5-6. Simpson 360 Power Supply, Schematic

5.4.3 The Rectifier Circuit is a full-wave, bridge type and converts the incoming AC into two unregulated DC voltages. The lower unregulated voltage is applied to a Series Type Regulator Circuit. The output from the regulator is 5 volts. The network comprising R1 and R2 provides the proper charging current for the battery.

NOTE: The relay automatically sets the circuit for battery charge when the AC power line is connected to the Instrument.

5.4.4 The DC-to-DC Converter changes the 5 volt DC regulator or battery voltage) into an AC signal. This AC signal is then stepped up and rectified to provide regulated outputs of ± 10 volts DC.

SECTION VI

MAINTENANCE

6.1 GENERAL

WARNING

The Instrument contains internal voltages which constitute a SHOCK HAZARD. Review what constitutes a SHOCK HAZARD as explained on page v. Internal adjustments or repairs should be performed only by qualified personnel who understand and can recognize what constitutes a SHOCK HAZARD, preferably a Simpson Authorized Service Center.

The Simpson 360 is carefully designed and constructed with high quality components. By providing reasonable care, and following the instructions in this manual, the user can expect a long, useful service life from his Instrument.

6.2 WARRANTY

The Simpson Electric Company warranty policy is printed on the inside back cover of the manual. Read carefully before requesting a warranty repair.

NOTE: For assistance of any kind, including help with the Instrument under warranty, contact your nearest Authorized Service Center for instructions. These centers are listed on the last pages of the manual. If you wish to contact the factory directly, give full details of the difficulty and include the instrument model number, serial number and date of purchase. Service data or shipping instructions will be promptly sent to you. If an estimate of charges for non-warranty or other service work is required, a maximum charge estimate will be quoted. This charge will not be exceeded without prior approval.

6.3 SHIPPING

6.3.1 Pack the Instrument carefully and ship it prepaid to the proper destination. Insure the Instrument.

6.4 BATTERY AND FUSE COMPARTMENT COVER REMOVAL

WARNING

Remove all power and input connections to the Instrument before removing the back cover. Do not operate the Instrument with the back cover removed.

To install or replace battery and fuses, remove the back cover as follows:

a. Turn the function selector switch to the OFF position.

b. Disconnect the line cord from the power source and all connections from the Instrument.

c. Loosen the single captivated screw and remove the cover.

d. Reverse the above procedure when replacing the cover.

6.5 BATTERY INSTALLATION

6.5.1 Recommended cells: Four "C" size, 1.25V, 1.5 ampere-hour, nickel-cadmium rechargeable (GE Cat. No. GCT 1.5 SB or Eveready CH 1-8).

CAUTION: Overall battery length must not exceed 1.940 inches.

CAUTION

Standard carbon zinc or alkaline "C" size cells can be used in an emergency. However, the power line fuse must be removed to prevent charging these cells in the Instrument. These cells do not have provision for pressure relief and can burst when charged. Immediately remove the cells when the emergency is over or when they are discharged, and replace with nickel-cadmium cells at your earliest convenience.

6.5.2 Install the cells as follows:

a. Remove back cover (refer to 6.4). Install the cells in pairs, according to the orientation designated on the battery holder label. Position the two inner cells in the battery compartment as shown in Figure 6-2. Push downward firmly at the points A and B as shown in illustration.

   NOTE: To remove the cells, pull upward at same points A or B, whichever point is negative (A, or inner cells and B on outer cells).

b. Check that the battery contacts are clean and making good connection.

c. Replace the cover.

d. For battery recharging, refer to paragraph 6.6.

e. Test the battery according to paragraph 4.3.2.

6.6 BATTERY RECHARGING

a. With the function selector switch set to the OFF position, insert the line cord plug into a 3-wire power outlet which conforms to the power requirements of the Instrument as marked on the rear panel, and to the latest electrical code.

b. Turn the function selector switch to BATT CHRG ONLY position. The LED pilot indicator will light. The battery is being charged at full rate.

   NOTE: If the battery test indicates a voltage less than 4.7 volts, leave the Instrument in BATT CHRG ONLY position for at least 15 minutes before operating.

c. Time for complete recharge of the battery is 16 hours nominal with the function switch set in the BATT CHRG ONLY position. Time for complete recharge of battery is nominally 30 hours while the selector switch is in either the DC, OHMS or AC position.

6.7 BATTERY CARE

6.7.1 Avoid allowing the cells to get completely discharged. Check the battery voltage periodically using the BATTERY TEST jack (refer to paragraph 4.3.2). Charge the battery whenever its voltage is close to, or below, 4.7 volts.

6.7.2 Do not operate the Instrument with discharged cells. Make sure to recharge all newly purchased batteries (refer to paragraph 6.6) for at least 15 minutes before operating the Instrument.

6.7.3 Observe polarity when installing the batteries.

6.7.4 Whenever the line cord is not connected, and the Instrument is not in use, remember to turn the function switch to the OFF position.

6.7.5 With nickel-cadmium cells installed in the 360, avoid storing in an area where the temperature exceeds +60°C.

6.8 FUSE REPLACEMENT

The line fuse, current fuse, and resistance fuse are mounted inside the battery and fuse compartment as shown in Figure 6-1. A spare for each fuse is provided. Use the following procedure to replace a fuse.

WARNING

Remove all power and input connections to the Instrument before removing the back cover.

6.8.1 Remove the back cover as described in 6.4.

6.8.2 Carefully lift the defective fuse from the holder and replace with appropriate fuse according to the following:

F1, line fuse (for 120V operation): 1/4 A, 250V, Type 8AG

(for 240V operation): 1/8 A, 250V, Type 8AG

F2, current fuse: 1/2 A, 250V, Type 8AG

F3, resistance fuse: 1/8 A, 250V, Type 8AG

6.8.3 Replace the back cover.

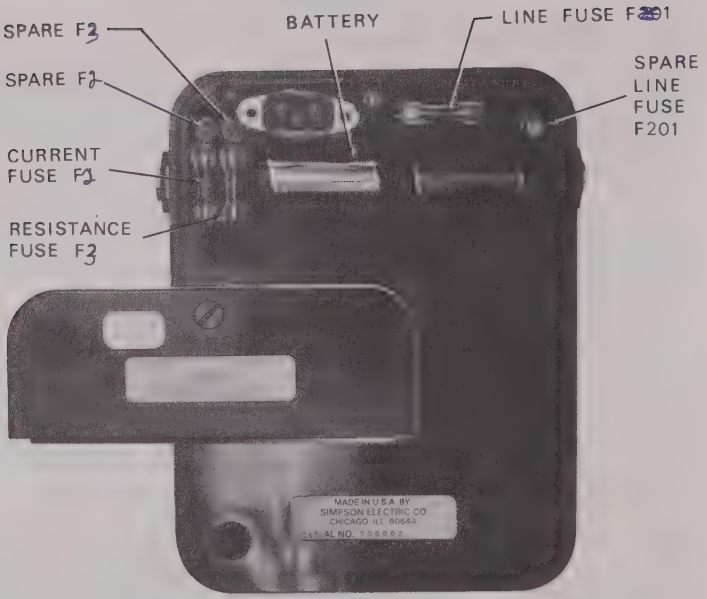

Figure 6-1. Simpson 360, Fuse Location

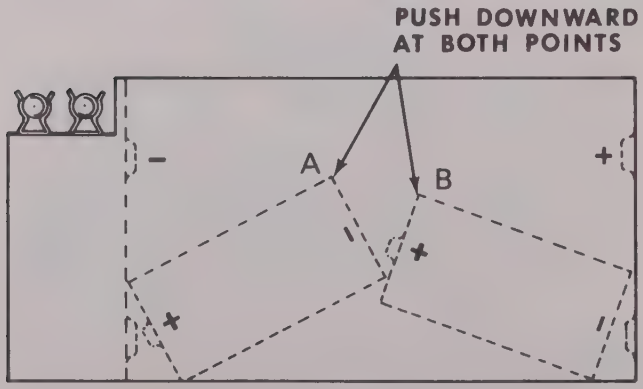

Figure 6-2. Battery Positioning for Installation

6.9 ZERO ADJUSTMENT

6.9.1 The Simpson 360 has been calibrated at the factory using precision instruments. The high order of accuracy and stability of the Instrument eliminate the need for frequent recalibration. However, should "zero adjustment" be required after a long period of time or extreme temperature conditions, use the following procedure:

a. Connect test leads to the + and COMMON terminals.

b. Turn the function selector switch to the DC, OHMS position.

c. Turn the range selector switch to the 2kΩ LOW POWER position.

d. Short the test leads together.

e. Allow the Instrument to warm up for 30 minutes.

f. Using an insulated screwdriver, adjust the potentiometer through the hole located directly below the analog display for a numerical display of .000, preferably with the polarity sign switching between a "+" and "−" indication.

6.10 PREVENTIVE MAINTENANCE

6.10.1 Daily Care:

a. Immediately clean all spilled materials from the Instrument and wipe dry.

WARNING

Do not attempt to clean this Instrument with the test leads connected to a power source or when it is connected to the AC power line.

b. Avoid allowing the battery to fully discharge. Check the battery voltage according to paragraph 4.3.2.

c. Whenever possible, avoid prolonged exposure or usage in areas which are subject to: temperature and humidity extremes, vibration or mechanical shock, dust or corrosive fumes, or strong electrical or electromagnetic interferences.

6.10.2 Monthly Care:

Verify Instrument calibration by performing operational checks using known value sources. If the need for calibration is indicated, contact your nearest Simpson Authorized Service Center.

6.10.3 Annual Care:

It is recommended that the Instrument be returned annually to a Simpson Authorized Service Center or the factory for a complete overall check, adjustment, and calibration.

6.10.4 Storage:

When the Instrument is not in use, store it in a location free from temperature extremes, dust and corrosive fumes, and mechanical vibration or shock.

6.11 TROUBLESHOOTING

6.11.1 If the Instrument does not yield satisfactory results, perform the following procedure before attempting maintenance on the Instrument:

a. Review and comply with the Preliminary Notes and Checks, listed in paragraph 4.3.

b. Check that all controls are positioned correctly for the parameter and range of value being measured and that the measurement is within the rating of the Instrument.

c. If the Instrument is battery operated, insure that the cells are charged and are installed properly (refer to 6.5).

d. If the Instrument is AC line operated, insure that power source is within the Instrument specifications, and free from excessive fluctuations and transients.

e. Insure that the environment in which the Instrument is being used is within the Instrument specifications.

f. Inspect the device being measured and the measurement test set-up to insure that proper shielding and grounding techniques have been used. If power line effects are suspected, operate the Instrument on battery. Also consider whether the Instrument is significantly affecting the circuit being measured.

6.11.2 If the steps taken in paragraph 6.11.1 do not yield satisfactory results, refer to the troubleshooting chart (Table 6-1). All other repairs and adjustments must be directed to a Simpson Authorized Service Center.

Table 6-1. Troubleshooting Chart

Symptom	Probable Causes	Cure
1. No indication on numerical and analog display when Instrument is battery operated. AC operation is OK.	Cells — Discharged, defective, not installed properly, making poor contact, or missing.	Check battery voltage. Refer to para. 4.3.2. If OK contact nearest Simpson Authorized Service Center.
2. LOW intensity on numerical display in battery operation.	Cells not fully charged.	Check battery voltage. Refer to para. 4.3.2. If battery checks low, remove cover and check that the cells are installed correctly and making good contact. Refer to 6.5. If they are, replace cover and charge battery overnight. Refer to para. 6.6.
3. No indication on the numerical and analog displays when Instrument is AC line operated (no cells installed).	a. Low or no voltage at power source receptacle. b. Line cord disconnected. c. Defective line cord. d. Line fuse open.	a. Restore correct voltage at power receptacle. b. Connect line cord. c. Repair or replace line cord. d. Replace Fuse F1. Refer to 6.8.

Table 6-1. Troubleshooting Chart (continued)

Symptom	Probable Causes	Cure
4. Batteries do not respond to charge. Instrument operation OK when connected to AC power.	Cells defective, not installed properly, making poor contact, or missing.	Remove cover and check that cells are installed correctly and making good contact. Refer to 6.5. If they are, check the voltages of the individual cells. Replace those which check significantly lower than nominal (1.25 volts).
5. Operation normal on all functions and ranges except on 200 Ω LOW POWER and 2KΩ LOW POWER resistance ranges.	Resistance fuse F3 open.	Replace fuse F3. Refer to 6.8.
6. Operation normal on all functions and ranges except AC and DC current.	Current fuse F2 open.	Replace fuse F2. Refer to 6.8.

Table 6-1. Troubleshooting Chart (continued)

Symptom	Probable Causes	Cure
7. Indications fluctuate and/or drift, even though indication is OK at 000 with the input terminals shorted, and at 1000 counts when using a stable and low impedance input.	Fluctuations and/or drift are being generated by the device being measured or the measurement test set up.	Use proper shielding, ground-techniques, and connections to minimize "pick-up" of unwanted signals due to ground loops, poor connections, and capacitive and/or inductive coupling. Operate Instrument on battery for complete isolation from the power line. NOTE: If the drift and/or fluctuation is coming from the device being measured, no cure is required, the measurement is valid, and the device must be corrected.

Table 6-1. Troubleshooting Chart (continued)

Symptom	Probable Causes	Cure
8. Indication is OK on battery. However, on AC operation, the reading fluctuates and/or drifts at 000, with the input shorted, and/or at 1000 counts using a stable and low impedance input.	AC power source is low or fluctuating (including transients).	Correct the power source or use Instrument on battery.
9. Same as 8 above, except indication OK on AC but not on battery operation.	a. Battery voltage low. b. One or more cells defective, not installed correctly.	a. Check battery condition. Refer to para. 4.3.2. If not OK charge battery, refer to para. 6.6. b. Remove back cover and check that cells are installed correctly and making good contact. If OK, replace all cells temporarily with conventional carbon zinc "C" size cells for checking purposes only. If problem still exists, contact nearest Simpson Authorized Service Center.

Table 6-1. Troubleshooting Chart (continued)

Symptom	Probable Causes	Cure
10. Slow response. Operation OK when using a low impedance input.	Parameter being measured has a high source impedance.	None required.
11. Accuracy not within specifications when checked with a stable, higher accuracy (at least 5 times better) low impedance (voltage measurements) source.	a. Instrument is out of calibration. b. Instrument not zeroed properly.	a. Contact nearest Simpson Authorized Service Center. b. Perform ZERO adjustment. Refer to para. 6.9.
12. Accuracy of Instrument is within specifications but measurements appear in error.	a. Instrument affects circuit being measured. b. Common and/or normal mode specification is being exceeded.	a. Study circuit being measured vs. Instrument specifications. Correct indications accordingly. b. Refer to cure in item 7.

SECTION VII

ORDERING INFORMATION, SCHEMATIC DIAGRAM, AND AUTHORIZED SERVICE CENTERS

Table 7-1. Items Furnished With Instrument

Quantity	Description	Part No.
1	Test Lead Set: One black and one red insulated lead having probe tips with provision for screw-on alligator clips (one red and one black supplied).	00115
1	Operator's Manual	5-116268

Table 7-2. Replacement Parts List

Reference Symbol	Description	Part No.
	AC Line cord	5-116271
	Cover, battery and fuse compartment	10-650201
	Knob, range selector switch	5-116232
	Knob, function selector switch	5-116216
	Test lead, Red	86-922480
	Test lead, Black	86-922480
	Alligator clip (without insulator)	1-115963
	Insulator, Alligator clip, Red	5-112479
	Insulator, Alligator clip, Black	5-111169
C1	Capacitor, .1mfd, ±10%, 630V	5-116189
C2	Capacitor, 910pf, ±5%, 630V	5-115981
C3	Capacitor, .0033mfd, ±5% 600V	5-112588
C4	Capacitor, 5000pf, ±2.5%, 63V	5-115776
C5	Capacitor, Variable, 5.5-60pf, 100V	5-116235
C6	Capacitor, 450pf, ±2.5%, 160V	5-115821
C7	Capacitor, Variable, 5.5-18pf, 350V	5-116193
C8	Capacitor, 5pf, ±.5pf, 300V	5-115164
C9	Capacitor, 7pf, ±5pf, 2500V	5-116267
C10	Capacitor, .1mfd, ±5%, 250V	5-114747
C11	Capacitor, .1mfd, ±20%, 100V	5-113612

Reference Symbol	Description	Part No.
C12, 13, 25	Capacitor, .001mfd, ±20%, 1kV	5-111119
C14	Capacitor, 250pf, ±10%, 1kV	5-113216
C15, 22, 23		
C29	Capacitor, 560pf, ±20%, 500V	5-112695
C16, 17, 21, 28, 30, 203, 204, 207-209, 217, 218, 221-223	Capacitor, 15mfd, −20%, +50%, 16V	5-115534
C18	Capacitor, 62pf, ±5%, 300V	5-116187
C19	Capacitor, 1.8mfd, ±10%, 100V	5-115998
C20	Capacitor, 100pf, ±10%, 1kV	5-113217
C26	Capacitor, .0047mfd, ±20%, 250V	5-111088
C24, 27	Capacitor, 2500pf, ±20%, 1kV	5-113985
C201	Capacitor, 200mfd, −10%, +75% 6V	5-116191
C202	Capacitor, .022mfd, ±20%, 100V	5-116188
C205, 206, 226	Capacitor, .1mfd, −20, +80%, 10V	5-113214
C210, 211, 212	Capacitor, 1200mfd, −10%, +75%, 12V	5-116192
C213	Capacitor, 3300pf, ±20%, 100V	5-116234
C214	Capacitor, 2.2mfd, ±10%, 16V	5-115533
C215	Capacitor, 1.0mfd, ±10%, 16V	5-115531
C216	Capacitor, .47mfd, ±10%, 16V	5-115530
C219	Capacitor, 6pf, ±5%, 300V	5-115539
C220	Capacitor, 62pf, ±5%, 300V	5-116187
C224	Capacitor, 22pf, ±5%, 300V	5-114990
D1, 4, 14, 201, 206, 211, 213	Diode, Rectifier, 1001	5-114005
D5	Diode, Light Emitting MV5025	5-116206
D6, 8, 9, 11, 13, 214, 215	Diode, IN914	5-112004
D7, 10	Diode, Zener 6.4V±5%, IN4576	5-116201
D12	Diode, Zener, 4.7V ±5%, IN750A	5-115476
D207	Diode, Bridge Rectifier, 1 AMP, W005	5-115945

346-0308-00 LM308N

Reference Symbol	Description	Part No.
D208, 209	Diode, Zener, 9.5V ±2%, DZ20215A	5-116203
D210	Diode, Zener, 6.0V ±10%, IN5233A	5-116202
D216, 217	Diode, IN456A	5-114946
F2	Fuse, Current, 1/2A, 250V, 8AG	5-116359
F3	Fuse, Resistance, 1/8A, 250V, 8AG	5-116358
F1	Fuse, Line, 1/4A, 250V, 8AG	5-113997
IC1, 2, 3	Integrated Circuits SCTR0176	5-116194
IC4	Integrated Circuits SN74L73N	5-115473
IC5	Integrated Circuits SN74L74N	5-115472
IC6, 7, 8	Integrated Circuits SN74L00N	5-115471
IC9	Integrated Circuits LM308H	5-115468
IC10	Integrated Circuits LM710CH	5-115470
IC201	Integrated Circuits LM307N	5-116195
IC202, 203	Integrated Circuits TOA8709V	5-115467
K201	Relay, Reed, N.C. Form B	5-116243
LED1, 2, 3	Readout, LED, 7-Segment	5-115943
LED4	Readout, LED, ±1 Symbol	5-115944
Q1, 205	Transistor, MPS3702	5-113864
Q2	Transistor, MPS3395	5-116459
Q3, 5, 7, 8, 10, 204, 211, 212	Transistor, MPS33394	5-112631
Q4, 9	Transistor, MPS3702	5-113864
Q6	Transistor, 2N4126	5-116458
Q201, 202	Transistor, D40DIN	5-115479
Q203, 207	Transistor, GET2222	5-115934
Q206	Transistor, 2N2907	5-116198
Q208	Transistor, D42C2	5-115932
Q209 210	Transistor, KE3956	5-116199
Q213, 214	Transistor, 2N4248	5-115484
Q215	Transistor, LS5458	5-115483
R1, 14, 62	Resistor, 100kΩ, ±5%, 1/4W	5-115506
R2	Resistor, 1MΩ, ±5%, 1/2W	1-117538
R3, 4, 248	Resistor, 22kΩ, ±10%, 1/4W	5-113623
R5	Resistor, 270Ω, ±10%, 1/2W	1-115386

Reference Symbol	Description	Part No.
R6	Resistor, 8.2MΩ, ±2%, 1/8W	5-115655
R7	Potentiometer, 1MΩ, 1/4W	5-116182
R8	Resistor, Precision Voltage Divider	5-115582
R12, 15	Resistor, 90.0kΩ, ±1%, 1/4W	5-115526
R16, 27	Resistor, 9.00kΩ, ±.1%, 1/8W	5-115492
R17	Resistor, 2398Ω, ±.1%, 1/8W	5-116161
R18	Resistor, 24.0kΩ, ±.1%, 1/8W	5-116163
R19	Resistor, 90Ω, ±.25%, 1/8W	5-116272
R20, 22	Resistor, Shunt Assembly, 2A and 10A	10-860148
R21	Resistor, 900Ω, ±.25%, 1/8W	5-116273
R23	Resistor, 9.0Ω, ±.1%, .75W	5-115576
R24	Resistor, 894Ω, ±.1%, 1.25W	5-116450
R25, 81, 83, 86, 92, 205, 208	Resistor, 1.0kΩ, ±10%, 1/4W	5-113871
R26	Resistor, 1.00kΩ, ±.1%, 1/8W	5-115489
R28, 29	Resistor, 495kΩ, ±.1%, 1/4W	5-115498
R31	Resistor, 392Ω, ±1%, 1/4W	5-117764
R32, 220	Resistor, 1.0kΩ, ±1%, 1/8W	5-115490
R33	Resistor, 2.2MΩ, ±10%, 1/8W	5-115487
R35	Resistor, 20.0kΩ, ±1%, 1/8W	5-112688
R36	Resistor, 33.2kΩ, ±1%, 1/4W	5-114964
R37	Resistor, 2.00kΩ, ±1%, 1/4W	5-115500
R38, 40	Resistor, 4.99kΩ, ±1%, 1/4W	5-115502
R39	Potentiometer, 100kΩ, ±20%, 1/2W	5-116184
R41	Potentiometer, 5kΩ, 1/2W	5-116183
R42	Resistor, 732Ω, ±1%, 1/8W	5-116159
R43	Resistor, 2.1kΩ, ±1%, 1/8W	5-116160
R44, 45, 70, 74, 89	Resistor, 56kΩ, ±10%, 1/4W	5-115513
R46, 48, 82, 93	Resistor, 8.2kΩ, ±10%, 1/4W	5-114977
R47, 50, 79, 90	Resistor, 3.3kΩ, ±10%, 1/4W	5-114973
R49, 67, 216, 225, 242	Resistor, 1.5kΩ, ±10%, 1/4W	5-113872

Reference Symbol	Description	Part No.
R51, 80, 85, 218, 219, 221, 223	Resistor, 18kΩ, ±10%, 1/4W	5-115512
R52, 53, 55, 72, 73, 75	Resistor, 12kΩ, ±10%, 1/4W	5-114978
R54, 76	Resistor, 1.82kΩ, ±1%, 1/4W	5-114596
R56, 77	Resistor, 14.3kΩ, ±1%, 1/8W	5-115495
R57, 59, 78	Potentiometer 2kΩ, 3/4W	5-116181
R58	Resistor, 5.76kΩ, ±1%, 1/4W	5-116179
R63, 64, 239, 243, 203, 204	Resistor, 100Ω, ±10%, 1/4W	5-114968
R65, 66, 206, 207, 241, 244, 245	Resistor, 10kΩ, ±10%, 1/4W	5-114962
R68	Resistor, 150Ω, ±10%, 1/4W	5-115510
R69, 228, 230	Resistor, 10kΩ, ±10%, 1/4W	5-113624
R71	Resistor, 1.2kΩ, ±10%, 1/4W	5-114971
R84	Resistor, 4.7kΩ, ±10%, 1/4W	5-113873
R87, 202	Resistor, 22Ω, ±10%, 1/4W	5-115509
R88	Resistor, 2.26kΩ, ±1%, 1/4W	5-116166
R91	Resistor, 120Ω, ±10%, 1/4W	5-116170
R94, 95, 96, 97, 98	Resistor, 390Ω, ±10%, 1/4W	5-113868
R201	Resistor, 820Ω, ±10%, 1/4W	5-113870
R209	Resistor, 680Ω, ±10%, 1/4W	5-113869
R210	Resistor, 91Ω, ±5%, 1/4W	5-116365
R211	Resistor, 27Ω, ±5%, 1/4W	5-116089
R212	Resistor, 2.7Ω, ±10%, 1/4W	5-116364
R213	Resistor, 750Ω, ±5%, 1/4W	5-116366
R214	Resistor, 560Ω, ±10%, 1/4W	5-115511
R215	Potentiometer, 470Ω, 1/10W	5-116236
R217	Resistor, 100kΩ, ±10%, 1/2W	1-113949

Reference Symbol	Description	Part No.
R222, 227	Potentiometer, 4.7kΩ, 1/10W	5-116186
R224	Resistor, 9kΩ, ±1%, 1/8W	5-116162
R226	Resistor, 15kΩ, ±10%, 1/4W	5-113621
R229, 238, 240	Resistor, 100kΩ, ±10%, 1/4W	5-115514
R231, 232, 233	Resistor, 30.1kΩ, ±1%, 1/4W	5-115505
R234, 251	Resistor, 47kΩ, ±5%, 1/4W	5-113628
R235	Resistor, 100Ω, ±10%, 1/4W	5-116164
R236	Resistor, 9.96kΩ, ±1%, 1/8W	5-115493
R237	Resistor, 90.0kΩ, ±1%, 1/8W	5-115497
R246	Resistor, 510Ω, ±1%, 1/8W	5-115488
R247	Potentiometer, 100Ω, 3/4W	5-116180
R249	Resistor, 6.8kΩ, ±10%, 1/4W	5-114976
R250	Resistor, 49.9kΩ, ±1%, 1/4W	5-115525
T201	Transformer, Power	5-116207
T202	Transformer, DC-DC Converter	5-116208

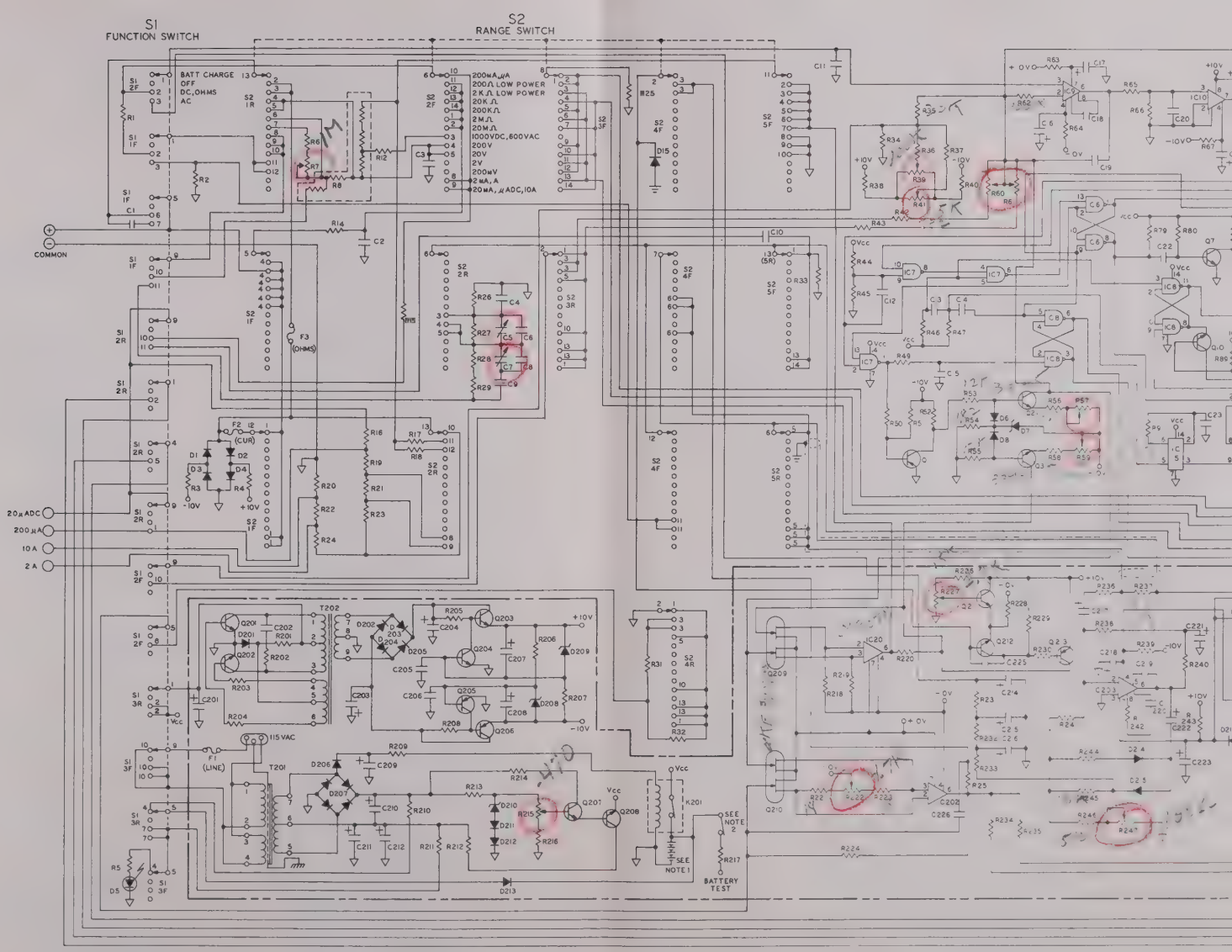

Figure 7-1. Schematic Diagram 7-7

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Simpson

ELECTRONIC FREQUENCY COUNTER TIMER MODEL 7016

- For measuring frequencies, elapsed time and events.
- Large, highly visible 0.55" planar numerical display.
- Frequencies from 5 Hz to 50 MHz in four ranges.
- Elapsed time from 0.01 sec. to 19999.99 sec.
- Totalizes from 1 to 1999999.
- IC construction assures high reliability, low power dissipation and compact design.
- Other standard features include: display storage selection, automatic decimal point location, variable display time, manual reset, overrange and gate time indications; 1 MEG Ω input impedance, and input overload protection.
- Interfacing with a high frequency prescaler such as the Simpson Model 7020, extends the Model 7016 counting capability to high frequency signals in excess of 500 MHz.
- Model 7016A incorporates 1 ppm internal oscillating accuracy as compared to 10 ppm for the 7016.
- Model 7016B incorporates additional BCD Output.

Warranty

SIMPSON ELECTRIC COMPANY warrants each instrument and other articles of equipment manufactured by it to be free from defects in material and workmanship under normal use and service, its obligation under this warranty being limited to making good at its factory any instrument or other article of equipment which shall within 90 days after delivery of such instrument or other article of equipment to the original purchaser be returned intact to it, or to one of its authorized service stations, with transportation charges prepaid, and which its examination shall disclose to its satisfaction to have been thus defective; this warranty being expressly in lieu of all other warranties expressed or implied and of all other obligations or liabilities on its part, and SIMPSON ELECTRIC COMPANY neither assumes nor authorizes any other persons to assume for it any other liability in connection with the sale of its products.

This warranty shall not apply to any instrument or other article of equipment which shall have been repaired or altered outside the SIMPSON ELECTRIC COMPANY factory or authorized service stations, nor which has been subject to misuse, negligence or accident, incorrect wiring by others, or installation or use not in accord with instructions furnished by the manufacturer.

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